PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
G01B 7/06, G01N 33/12
A22C 17/00, A22B 5/00

A1

(11) International Publication Number: WO 94/02803

(43) International Publication Date: 3 February 1994 (03.02.94)

(21) International Application Number: PCT/GB93/01564

(22) International Filing Date: 23 July 1993 (23.07.93)

(30) Priority data:
9215866.6 25 July 1992 (25.07.92) GB

(71) Applicant (*for all designated States except US*): AEW INTERNATIONAL LIMITED [GB/GB]; Gresham House, Pinetrees Business Park, Salhouse Road, Norwich NR7 9BB (GB).

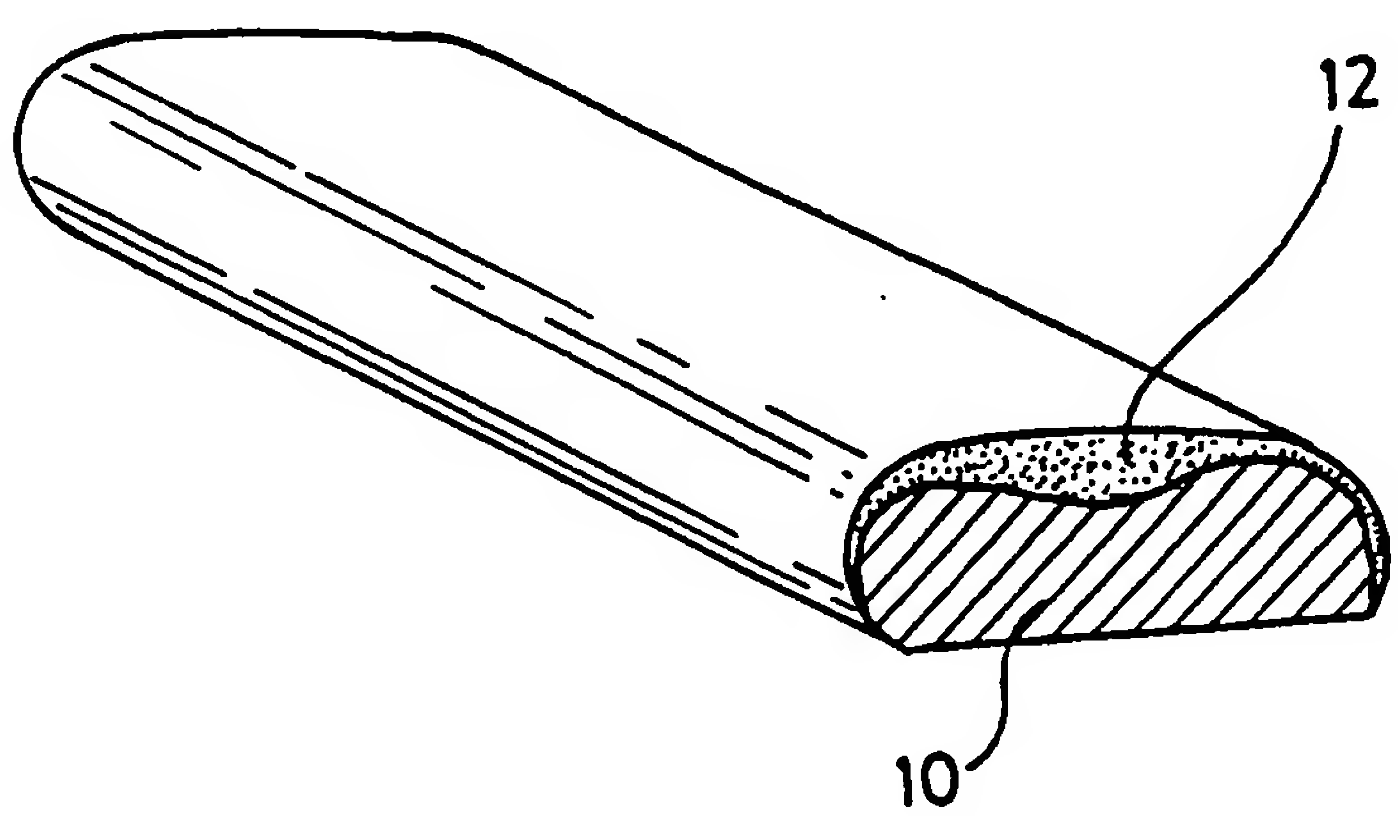
(72) Inventor; and
(75) Inventor/Applicant (*for US only*) : WHITEHOUSE, John, Arthur [GB/GB]; 5 Old Rectory Close, Mulbarton, Norwich NR14 8LX (GB).

(74) Agent: KEITH W. NASH & CO.; Pearl Assurance House, 90-92 Regent Street, Cambridge CB2 1DP (GB).

(81) Designated States: GB, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: MEASUREMENT DEVICE



(57) Abstract

In a method of determining the thickness of a layer of fat on one side of a joint of meat, the joint of meat is positioned on an electrically conductive surface with the layer of fat uppermost, and an electrically conductive needle is lowered into and through the fat layer until it penetrates into the lean meat therebelow. The needle, the joint and the electrically conductive surface form part of an electrical circuit, the electrical resistance of which drops significantly as the end of the needle passes from the fat layer into the lean meat since the latter has a much lower resistivity than the fat layer. Thus, by noting the position of the probe when it first contacts the joint (thus creating an electrical circuit) and the position of the probe when the significant drop in resistance occurs, the thickness of the layer of fat can be determined. A matrix of such probes may be provided so that the thickness of the fat layer at different parts of the joint can be determined in one invasive operation.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NE	Niger
BE	Belgium	GN	Guinea	NL	Netherlands
BF	Burkina Faso	GR	Greece	NO	Norway
BG	Bulgaria	HU	Hungary	NZ	New Zealand
BJ	Benin	IE	Ireland	PL	Poland
BR	Brazil	IT	Italy	PT	Portugal
BY	Belarus	JP	Japan	RO	Romania
CA	Canada	KP	Democratic People's Republic of Korea	RU	Russian Federation
CF	Central African Republic			SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovak Republic
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	UA	Ukraine
DE	Germany	MG	Madagascar	US	United States of America
DK	Denmark	ML	Mali	UZ	Uzbekistan
ES	Spain	MN	Mongolia	VN	Viet Nam
FI	Finland				

Title: Measurement device

Field of invention

This invention concerns measurement devices in particular a device for measuring the depth of fat on meat products such as steaks, chops, cutlets and the like.

Background to the invention

In many applications where meat and like products are cut into steaks, chops, cutlets etc it is necessary that those portions are cut at a constant weight despite natural irregularity of cross-sectional areas of the strip from which they are cut. Todays marketplace also requires that the amount of external fat present on a portion is closely controlled and in general this is required to be of a considerably smaller depth than would normally occur naturally.

Computer controlled automatic equipment exists to perform the first of these tasks namely the cutting of the portions of constant weight from strips of variable cross-section. However once a portion has been cut to the required weight it is not possible to trim the external fat to the desired thickness since this would ultimately result in an underweight portion.

Pre-trimming the external fat is very difficult because the thickness of the fat layer is not known nor is the thickness of the fat layer constant in any direction.

The option of deliberately cutting portions which are overweight so that the fat can subsequently be trimmed and result in an on-weight portion is not viable since it is difficult to estimate how much overweight allowance should be made and poor yields result.

It is an object of the present invention to provide a solution to this problem by assessing the depth and topography of the fat layer of the strip of meat or similar product prior to the strip being portioned.

It is another object of the invention to utilise data collected from such an assessment to operate a cutting head to reduce the external fat layer to a required thickness.

Summary of the invention

According to one aspect of the present invention a method of determining the thickness of a layer of fat on one side of a joint of meat comprises the steps of:

1. Positioning the joint of meat on a conductive surface with the lean side in contact with the said surface and the layer of fat uppermost,

2. Lowering a conductive probe into and through the fat layer until the probe penetrates into the lean meat below the fat layer,

3. Measuring the electrical resistance of the circuit comprising the conductive surface, joint of meat and probe which resistance varies as the probe touches and

penetrates the fat and finally comes into contact with the lean meat therebelow, and

4. Noting the distance through which the conductive probe travels between point of entry into the fat layer and point of entry into the lean layer denoted by changes of resistance.

The measurement of distance may be made directly as by means of a linear transducer.

Alternatively the probe may be moved in a controlled manner at constant speed and the time between the two significant changes of resistance corresponding to the point of contact between the probe and the layer of fat and between the probe and the lean meat therebelow noted and converted using a constant to give a measure of depth.

The technique is made possible by virtue of the significantly different resistivity of fatty tissue relative to lean tissue. In general the lean tissue is markedly more conductive than fatty tissue so that the measured resistance will be seen to decrease significantly as the probe penetrates the lean tissue.

A servo system may be provided to retract the probe as soon as the lean tissue has been contacted so as to reduce damage to the meat below the fatty layer.

Such a servo system may be triggered by the significant increase in conductivity noted as the probe enters the lean material or may be triggered by means of a resistance to movement sensor associated with the probe drive since

in general the fatty layer will present less resistance to movement than the lean muscle located below the fat layer.

The method envisages the use of either form of sensor.

By sampling the current and recording in memory the vertical position at which the different changes in current flow occur, the distance through which the needle has travelled from the surface of the meat to the internal fat muscle boundary can be computed and hence the thickness of the fat layer at the point of penetration can be deduced.

In some joints it is sufficient to make one reading since the fat layer can be assumed to be substantially uniform.

In the general case however, variation in thickness of the fat layer will occur over the area of the joint and a fat thickness profile can be computed by penetrating the fat layer at different positions over the area of the joint and storing the different thickness values for the different points over the surface of the joint.

The series of different thickness values can be obtained by scanning the joint with a single needle either by moving the needle relative to the joint or the joint relative to the needle, in each case provision being made to retract the probe before relative movement occurs to reposition the probe and joint.

The process may be speeded up by providing a line of such probes equally spaced apart and scanning the joint by introducing relative movement perpendicular to the line of

the probes between the joint and the probes. Each of the probes must be electrically separate from the others and separately addressable.

In a further development, the line of probes may be replaced by a matrix array of probes so that large areas of a joint of meat can be inspected simultaneously so that where the area concerned is greater than the area of a joint, no scanning is required and where this is not the case the number of movements needed to effect the scanning of the whole joint is significantly reduced.

Preferably the array of probes is greater than the largest area of joint which is to be presented thereto since probes which do not penetrate either fat or lean meat will not register any electrical conductivity.

If the probe spacing is relatively small, the information obtained may be sufficiently accurate to also indicate the area of the joint (in a plane which extends perpendicular to the probes and therefore parallel to the fat layer under investigation) which together with an absolute thickness value (which may be derived from the height information) can be used to compute a volume value for the joint with or without the fat layer included in the computation. A single invasive measurement using a multi probe head may thus provide not only volume (and indirectly weight) information but also thickness of fat layer.

In the event that close spacing of the probes is found to introduce unwelcome interaction between different probes, the probes may be scanned in a pattern either one at a time or in groups sufficiently separated as to prevent or

reduce electrical interaction to an acceptable minimum.

If a measure of the area of the meat joint on the underside is also desired (since joints may not be of uniform area throughout their thickness), the conductive plate on which the meat joint is positioned may itself be divided into a large number of separate electrically insulated regions which for the purpose of the depth measurement are electrically connected together to form a single electrical surface but for area measurement can be interrogated separately once the probes have been driven into the joint (either the fat layer or the layer below) so as to provide a conductive path through the joint and to each of the separate points therebelow and a profile of the shape of the cross-section of the joint sitting on the platform can be obtained by separately interrogating the different regions of the platform and determining which of the regions is in contact with the conductive joint and those which are not. Again provided the number of such separate interrogatable regions is high enough, a relatively accurate measure of the area can be ascertained as also can the shape of the section and the pattern and number of interrogated sections can be stored in association with the information relating to other parameters of the joint so that a true picture of both volume, weight and fat thickness of the joint can be ascertained and recorded to facilatate future processing of the joint.

The plate on which the joint sits may be substantially smooth or may be formed with one or more spikes on which the joint of meat is impailed. Typically an array of spikes is provided corresponding in spacing to the array of probes but out of phase with the probes so that the

spikes protrude upwardly between the downwardly protruding ends of the probes.

Where total penetration of the joint is desired, the plate may be apertured with the apertures in registry with the probes so that after the probes have penetrated the meat the pointed ends can enter the openings in the plate thereby preventing damage from occurring.

The invention also lies in apparatus for performing the above method which apparatus comprises a support plate on which a joint of meat can be located, at least one probe movable in a direction towards the joint of meat to first penetrate a fat layer and thereafter lean meat in the joint, electrical circuit means of which the plate and the probe form a part and which is completed when the probe enters the joint, resistance measuring means associated with the circuit means to indicate the electrical resistance between the probe and the plate which varies significantly as between the fat layer above and the lean meat below and electrical transducer means for indicating the distance travelled by the probe between initial contact with the fat layer and initial contact with the lean meat below the fat layer to thereby enable a depth of fat measurement to be obtained.

The apparatus preferably includes a plurality of such probes to enable a large number of points across the width of the joint to be sampled simultaneously and each of the probes is addressable separately to enable individual depth measurements to be obtained and thereby fat layer thickness measurements to be derived for each of the sample points in the array of probes.

The array of probes may be linear or as a matrix.

The plate may be planar or spiked to thereby hold the joint in position particularly where it is necessary to move the joint relative to the probes.

According to a preferred feature of the invention, the information from the fat depth probes is stored and subsequently read out and converted to control signals for a cutter device which is adapted to trim the joint using the information stored in relation to the depth of fat and contour of the fat-lean meat interface. In this way the fat can be removed leaving a uniform depth of fat over the surface of the lean meat.

The cutter device may comprise a plurality of cutters mounted in a frame positioned vertically above a conveyor onto which the joint of meat is located and the height of each of the cutters above the conveyor is adjustable and is controlled by a servo drive and the stored signals are used to position the height of each of the cutters as the joint aproaches the cutting station so as to trim the fat to a required and desired depth.

For simplicity one cutter is provided for each probe although this is not essential and where the number of cutters is less than the number of probes the signals can be averaged so as to provide the appropriate control signal for each cutter and where the number of cutters is greater than the number of probes, the adjoining probe values can be extrapolated to produce an appropriate control signal for cutters located between the positions of the probes in the original array.

The invention thus also lies in apparatus for performing the cutting step as well as the fat depth measuring step.

The invention also lies in a control system based on a computer for interpreting information from the probes and building a three-dimensional digital image of the joint or the fat layer or both and using the stored image and data derived therefrom to provide vertical displacement control data for a cutting device typically a multiple-head cutting device.

In a practical embodiment, a conveyor is provided on which strips of product are placed with the fat layer uppermost. A fat depth measuring probe or probes is situated above the conveyor at a measuring station and output data from the probe is supplied to a computer.

Typically the conveyor is advanced rapidly so carrying the meat towards the probe. A proximity detector light beam or other device is situated upstream of the probe so as to detect the arrival of a strip of meat and a signal therefrom to the computer slows the conveyor and positions the end of the strip directly below the probe or probes.

A drive is provided for raising and lowering the probe head and signals from the computer serve to operate the drive means to lower the probe into the fat layer enabling the position of the fat surface and the fat muscle boundary to be logged into the computer.

In a typical arrangement where a single line of needle like probes is located above the conveyor with the line substantially perpendicular to the direction of movement of the conveyor, the probe head is successively raised and

lowered with controlled advance of the conveyor between each raising and lowering so that successive readings at know distances along the strip are obtained. The sequence is controlled until the strip of product has been entirely sampled and a complete map of the fat and fat-muscle boundary is in memory.

The conveyor drive is now accelerated to advanvce the meat rapidly towards a cutter head where the product is detected by similar proximity or light beam means. At this stage the computer positions the strip directly beneath the cutter head, the cutters are lowered by servos driven by signals from the computer to positions corresponding to the first set of data stored in the digital map of the fat layer and the conveyor is slowly advanced so as to drive the product through the cutting station while the cutters rise and fall following the contours of the "map" within the computer memory. Depending on how closely the fat-muscle boundary is followed, so no fat or a given thickness of fat is left on the surface of the meat.

When the entire length of the product has been moved through the cutting station, and the fat layer of the strip is totally trimmed to the required specification, the cutters retract to their uppermost positions, the trimmed meat joint is conveyed to a checking or packing station and the fat is removed for processing elsewhere.

Before the next strip of product is processed, the needles and cutters may be automatically sanitised.

After a strip of meat has been processed before the next arrives, the needle-like probes are adapted to make

contact with a reference plate at a known depth. This enables an electrical circuit to be completed for each of the needle-like probes serving two functions:

1. the computer can run a check programme to determine whether the linear transducer is functioning correctly.

2. by checking the current flow through all the needle-like probes, a check is made that all the needles in the array are still present.

In the event that a needle is not sensed, it is assumed that it has become lodged in the strip just processed and a warning signal is generated so that the strip can be rejected and further operation inhibited until the problem has been rectified.

Where a complete two-dimensional array of needle-like probes is provided encompassing an area at least equal to that of the largest product likely to be presented to it, the step wise motion of the product through the probe station can be dispensed with so that the product is simply moved to the probe station in one movement, is sensed and then moved on to the cutter in a second single movement.

The cutter station may be formed from an arrangement of a plurality of industry standard rotary trimming knives operating across the product rather than along its length.

Where a single line of needle-like probes extends transversely across the conveyor, the size of the incremental conveyor movement between operation cycle may

be made variable thereby enabling a compromise between speed and accuracy to be obtained. Thus for example where a product is known to have a relatively uniform fat depth, the step width between samples could be increased without any significant deterioration in accuracy and advantage could be taken of the increased processing speed.

The invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 shows a typical meat joint before trimming;

Figure 2 shows the same meat joint after trimming to remove the fat;

Figure 3 is a block diagram of an overall system incorporating the invention;

Figure 4 is an enlarged view of the fat depth measuring station;

Figure 5 shows the operating cycle of one needle probe at the fat depth measuring station;

Figure 6 shows graphically the current flow profile and transducer output signal, and

Figure 7 shows a general arrangement of the proposed system whereby a fat depth measuring station is followed by a cutter to trim fat from the meat portion on the conveyor.

Figure 8 shows diagrammatically, the fat depth measuring station and the cutter mounted on a common machine bed.

Detailed description of the drawings

Figure 1 shows a joint of meat the majority of which is lean muscle denoted by 10 but which as usual includes an outer layer of fat 12. To make the meat more acceptable to the consumer, much of the fat is removed and typically the fat is removed so as to leave a uniform layer of approximately 3mm depth as shown at 14 in Figure 2.

Figure 3 is a block diagram of a fat trimming meat processing system embodying the invention. The system divides into four sub-systems, the conveyor, the probe head, the cutter head and the control system.

The conveyor 16 is typically of stainless steel and has a surface which carries small spikes 18. These are intended to provide grip and traction for the meat strip to be processed denoted at 20. They also ensure electrical contact between the meat and the conveyor surface.

The conveyor is driven by a servo system with a shaft encoder 22 providing position feedback.

The conveyor serves to move the meat strip perpendicular to the plane of the paper first through the fat depth probe head and subsequently below a cutter head which is driven by signals from a control system so as to remove fat from the fat layer sufficient to leave a uniform layer of fat over the strip.

The probe head which is shown in more detail in Figure 4 comprises a linear array of thin needles one of which is denoted by reference numeral 24 carried by a frame 26

which itself is mounted above the conveyor 16. The needles are equi-spaced and are electrically isolated one from the other. The needles point vertically downwards towards the conveyor and are arranged in a single row which extends transversely across the conveyor.

The frame on which the needle assembly is mounted is free to move vertically and is driven up and down typically by a crank mechanism shown in Figure 4 and comprising a cranked drive arm 28 mounted in bearings 30, 32, 34 and 36 with two connecting rods 38 and 40 joining the cranked sections of the drive arm 28 to the frame 26. A linear transducer 42 produces an output signal proportional to the displacement of the frame unit from its uppermost position which is defined as its reference position.

Figures 3 and 4 show the needles in a fully penetrated position and the cranked parts of the arm 28 are shown in Figure 4 in their lowest position. Rotation of the arm 28 through 180° raises the frame 26 by sufficient height so that the needles are clear of the meat. This reference position is the one in which the frame normally rests to allow the meat to pass below the probe head.

In accordance with the invention, the meat is brought to rest below the probe head and the crank drive 28 is operated so as to cause the needles to move in a downward sense to penetrate the fat layer and then enter and pass through the lean muscle layer of the joint 20.

A signal source 44 is connected to the conductive conveyor and when needles make contact with the meat an electrical circuit is completed so that electrical current flows. The conductivity of the fat layer has been found to be

considerably lower than that of the lean muscle below the fat layer so that when a needle first penetrates the fat layer the current flow is relatively small but when the needle penetrates the fat lean barrier and enters the lean muscle below the fat, the current flow increases. This change in current flow can be detected as can the onset of initial current flow thereby giving a measure of the depth of the fat layer. The distance travelled by the needle from the initial penetration of the fat to the fat lean boundary is computed with reference to signals from the linear transducer 42 so that a value of fat depth can be computed.

The control system shown in Figure 3 within the dotted outline 46 includes a multiplexer 46 which receives information from the transducer 42 and the current from the needles such as 24. The multiplexer also generates addresses for the different needles and associates the needle current with the probe depth signal for supply to a processor 50. The latter routes the data with or without modification into a memory 52 together with information relating to conveyor displacement from the encoder 22 so that a map of fat depth over the whole strip of meat can be built up in the memory 52.

The fourth part of the system also shown in Figure 3 comprises the cutter head. This is located above the same conveyor 16 albeit at a distance from the fat depth probe head. The cutter head includes a number of separate cutters such as 54 each individually adjustable in height relative to a frame 56 positioned at a fixed height above the conveyor 16 and the height of each cutter being adjustable by means of servo drives such as 58. It will be seen from Figure 3 that by adjusting the height of the

cutters so the profile of the fat to lean meat interface can be followed either to remove all fat or to remove fat and leave a uniform thickness layer at the interface as is shown in Figure 3.

Signals for driving the servos such as 58 are obtained from the control system 46 by demultiplexing data from the processor 50 using a demultiplexing device 60 to which signals from the processor are supplied comprising cutter address and cutter depth. The purpose of the demultiplexer is to route the appropriate signal to the appropriate servo.

Information for generating cutter address and cutter depth signals is obtained by the processor from the data within the memory 52 corresponding to the three-dimensional profile of the fat/lean interface.

Although not shown, a motor drive for the crank shaft 28 is provided and signals for rotating the crank shaft 28 by energising the motor are also provided from the control system along line 62. The processor generates a signal to crank down the probe head 26 when the meat strip 20 is below the head 26 and also generates a stop signal along line 64 to arrest the movement of the conveyor 16.

After the probes have fully penetrated to their lowest position the continued rotation of the crank drive ensures the probes are lifted clear of the meat strip whereafter an appropriate signal along line 64 causes the conveyor to increment by a given distance and the process is then repeated.

Information relating to the incremental movement between

probe position is entered by means of a keypad 66 associated with the apparatus.

A target fat thickness to be left on the strip of meat can also be programmed into the control system via the keypad 66 and this data supplied to the processor along line 68. This data represents a fixed offset of the cutter position relative to the mapped fat/lean interface.

Figure 5 shows the operating cycle of one needle.

Figure 6 shows the probe current and the linear transducer output during the cycle shown in Figure 5.

At position 1 the needle is in free air and no current flows.

At position 2 the needle just touches the surface of the product and current starts to flow. The output of the linear position transducer is logged at that point A and represents the surface product.

At position 4 the needle has descended further into the product to the fat muscle boundary and a marked increase in current flow occurs and again the output of position transducer is logged corresponding to position E.

The needle descends further into the product and reverses. As the needle is withdrawn it passes through the fat muscle and the product outer surface again and these two positions seen at D are logged a second time and averaged with the readings A and B.

The mean of the difference of the two sets of readings is

stored as a depth of fat layer at the point sampled.

Figure 7 shows how the probe head and cutter head can be mounted above a conveyor 16 with a strip of meat 70 located on the conveyor. Rollers 72 and 74 denote by upward displacement when the strip of meat 70 arrives first at the probe head and then at the cutter head and also denotes by reverting to its vertically down position, when the strip of meat 70 is to just clear the probe head and then subsequently the cutter head. One of the needles 24 is shown below the probe head and one of the cutters 54 is shown below the cutter head.

With reference to Figure 8, the frame 26 is laterally located above the conveyor 16 by means of corner posts 100, 102, 104 and 106 which are, in turn, mounted on a common machine bed 108. The frame 26 is slideably mounted on the posts 100, 102, 104 and 106 so that it may move vertically as a result of the rotation of the arm 28 (which is located within the bed 108 beneath the frame 26). For the sake of clarity, the connecting rods 38 and 40 extending from the arm 28 to the frame 26 have not been shown in Figure 8.

The frame 56 for the cutter is also mounted on four corner posts, 110, 112, 114 and 116, but unlike the frame 26, is fixed to its corner posts so that the vertical positions of the cutters 54 is controlled solely by the servo drive 58 operating in response to control signals from the control system 46. Fat removed by the cutters 54 is ejected along a chute 138 into a waste container not shown.

Each of the rollers 72 and 74 is mounted at one end of a

respective trailing arm 120 and 122 which is in turn pivotally mounted to the cross-piece of a support frame in the shape of an inverted 'U' (Figure 7). The respective support frames are denoted by the references 124 and 126 in Figure 7. The vertical members of each 'U'-shape frame are attached to the bed 108, one on either side of the conveyor 16, in a similar fashion to the posts on which the frames 26 and 56 are mounted. For the sake of clarity, the rollers 72 and 74 and their associated support frames and trailing arms have been omitted from Figure 8.

In use, joints of meat are fed onto the conveyor 16 by an upstream conveyor belt 130 to which joints of meat are supplied from a feed conveyor 134. Joints of meat which have been processed by the system are then transferred from the conveyor 16 to a downstream conveyor 132 which conveys the joints to a meat cutting device 136, which may be for example a filleting or chop cutting machine, such as the APC saw marketed by AEW Engineering Limited.

Claims:

1. A method for determining the thickness of a layer of fat on one side of a joint of meat, the method comprising the steps of:

a) positioning the joint of meat on a conductive surface with the lean side in contact with said surface and the layer of fat uppermost;

b) lowering a conductive probe into and through the fat layer until the probe penetrates into the lean meat below the fat layer;

c) measuring the electrical resistance of the circuit comprising the conductive surface, the joint of meat and the probe, which resistance varies as the probe touches and penetrates the fat and finally comes into contact with the lean meat therebelow;

d) determining and noting the distance through which the conductive probe travels between point of entry into the fat layer and point of entry into the lean layer denoted by changes of resistance.

2. A method according to claim 1 in which said distance is determined by directly measuring the distance travelled by the probe.

3. A method according to claim 1 in which the distance is determined by moving the probe in a controlled manner at a controlled speed, noting the time delay between the two significant changes of resistance respectively

corresponding to the time of contact between the probe and the layer of fat and the time of contact between the probe and the lean meat therebelow, and converting the delay, using data on the speed of the probe, into a measure of depth.

4. A method according to claim 3 in which the probe is lowered into the meat at a constant speed.

5. A method according to any of the preceding claims in which the probe is retracted by means of a servo system on making contact with the lean tissue, so as to reduce damage to the meat below the fatty layer.

6. A method according to claim 5 in which the servo system is triggered by the significant change in resistance noted as the probe enters the lean material.

7. A method according to claim 5 in which the servo system is triggered by means of sensors responsive to mechanical resistance to movement of the probe.

8. A method according to any of the preceding claims in which the fat layer is penetrated at different positions over the area of the joint by at least one probe, and the different values for the different points over the surface are stored.

9. A method according to claim 8 in which the series of different thickness values is obtained by scanning the joint with a single probe, which is retracted from the joint before relative movement between the joint and the probe occurs to reposition the probe and joint.

10. A method according to claim 8 in which the joint is penetrated by a plurality of separately addressable probes which are arranged in a linear array and in which the joint is scanned by relative movement between the joints and probes in a direction perpendicular to the linear array.

11. A method according to claim 8 in which the joint is penetrated by a purality of probes arranged in a matrix array so that large areas of the joint of meat can be inspected substantially simultaneously.

12. A method according to claim 11 in which the area over which the array of probes is distributed is greater than the largest area of the joint.

13. A method according to claim 12 in which the number of probes which make contact with the joint, and the height at which each such probe contacts the fat or lean layers of the joint are used to compute the volume of the joint respectively with and without the fat layers.

14. A method according to any of the preceding claims in which the area of the underside of the joint is also determined, wherein the conductive surface on which the meat joint is positioned comprises a plate divided into a large number of separate electrically insulated regions which for the purpose of the depth measurement are electrically connected together to form a single electrical surface, and wherein the method includes the steps of interrogating each region separately once the probes have been driven into the joint so as to determine whether a conductive path through the joint and to the region being interrogated has been established so as to

determine which of the regions are in contact with the joint and which of the regions are not, and calculating the area of the underside of the joint from the number of regions in contact therewith and from the known area of each such region.

15. A method according to any of the preceding claims in which the thickness of the fat layer is stored and subsequently read out and converted to control signals for a cutter device adapted to trim the joint.

16. Apparatus for performing a method according Claim 1, the apparatus comprising a support plate on which a joint of meat can be located, at least one probe moveable in a direction towards the joint of meat to first penetrate a fat layer and thereafter lean meat in the joint, electrical circuit means of which the plate and the probe form a part and which is completed when the probe enters the joint, resistance measuring means associated with the circuit means to indicate the electrical resistance between the probe and the plate and electrical transducer means for indicating the distance travelled by the probe between initial contact with the fat layer and initial contact with the lean meat below the fat layer to thereby enable a depth of fat measurement to be obtained.

17. Apparatus according to claim 16 in which the apparatus includes a plurality of probes for enabling a large number of points across the width of the joint to be sampled simultaneously, means for addressing each of the probes separately to enable individual depth measurements to be obtained and thereby fat layer thickness measurements to be derived for each of the points sampled by the array of probes.

18. Apparatus according to claim 17 in which the probes are arranged in a linear array.

19. Apparatus according to claim 17 in which the probes are arranged in a matrix array.

20. Apparatus according to either of claims 18 or 19 in which the plate is spiked thereby to hold the joint in position.

21. Apparatus according to claim 20 in which a plurality of spikes project from the support plate, the spikes being arranged in an array in which the distribution of spikes corresponds to that of the probes, but in which the spikes are out of phase with the probes so that the spikes protrude upwardly between the downwardly protruding ends of the probes, when the latter are lowered.

22. Apparatus according to claim 21 in which the plate includes a plurality of apertures in registry with the probes, the arrangement being such that after the probes have penetrated the meat, the lower ends of the probes can enter the apertures, thereby to prevent damage to the probes.

23. Apparatus according to any of claims 16 to 22 in which there is provided storage means for storing information on the thickness of the fat layer of a joint, and a cutter device operative, in response to control signals derived from information stored by the storage means, to trim the joint.

24. Apparatus according to claim 23 in which the cutter

device comprises a plurality of cutters mounted in a frame positioned vertically above a conveyor onto which the joint of meat is located, the height of each of the cutters above the conveyor being adjustable and controlled by a servo drive wherein the stored signals are used to position the height of the cutters as the joint approaches the cutting station so as to trim the fat to a required and desired depth.

25. Apparatus according to claim 23 or claim 24, further comprising means for automatically sanitising the needles and cutters, after a joint has been trimmed.

26. A control system for use with apparatus according to any of claims 23 to 26, and comprising a computer for interpreting information derived from the probes and building a three dimensional digital image of the joint off the fat layer or both and means for outputing data derived therefrom to provide vertical displacement control data for the cutting device.

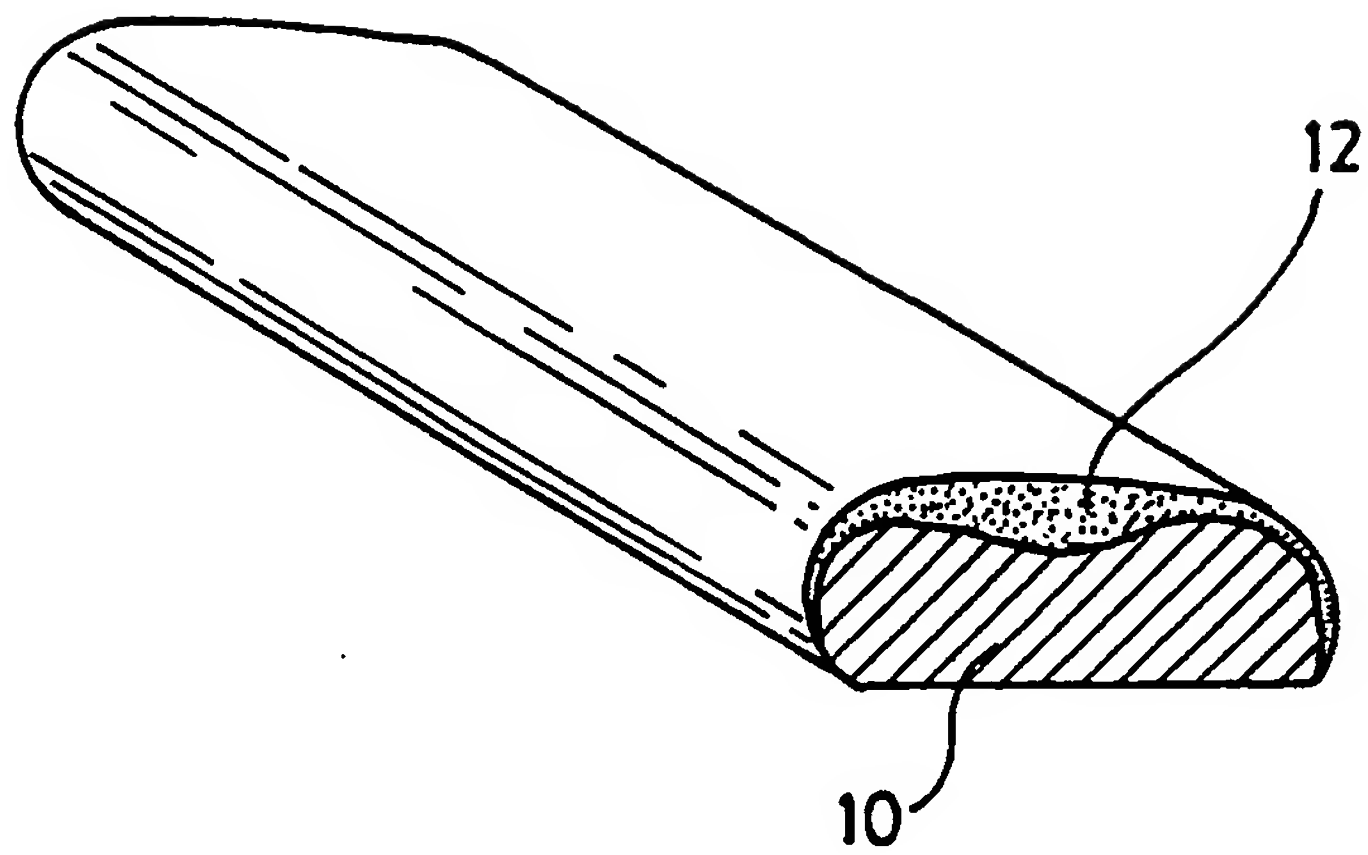


Fig. 1

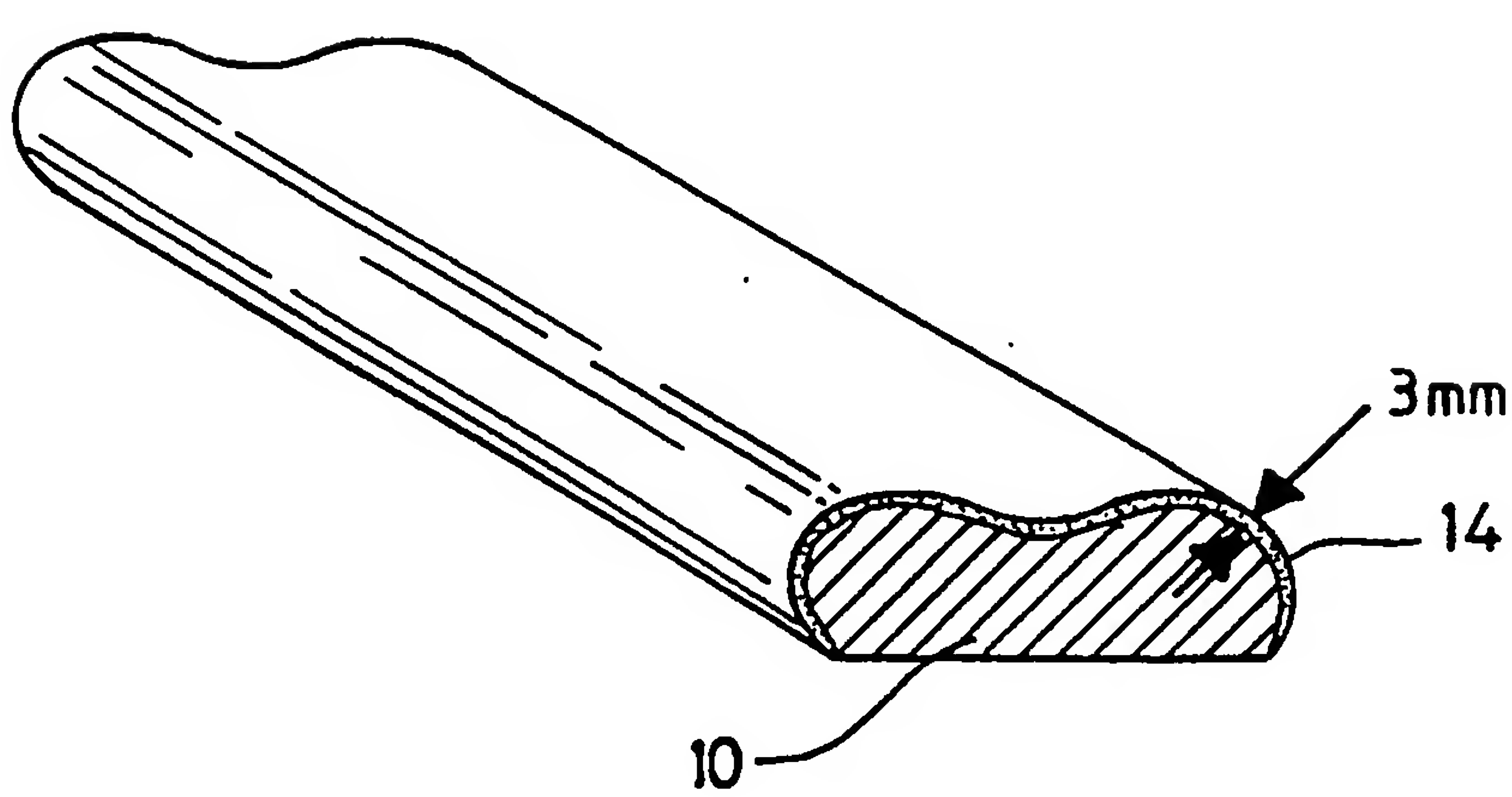


Fig. 2

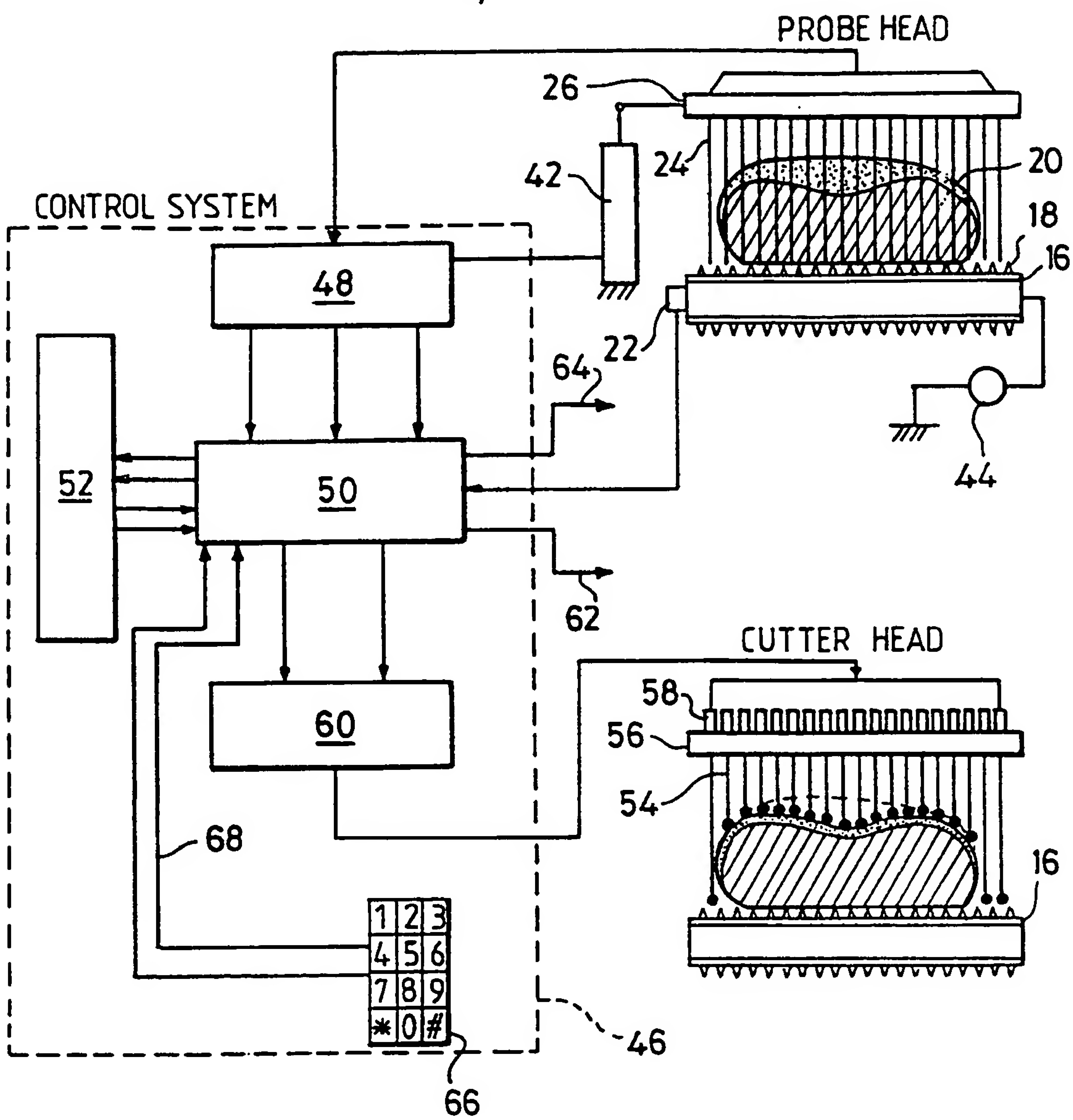

PROBE HEAD
26
42
24
20
18
16
CONTROL SYSTEM
48
52
50
60
22
64
44
62
CUTTER HEAD
58
56
54
16
68
1 2 3
4 5 6
7 8 9
* 0 #
46
66

Fig. 3

3/7

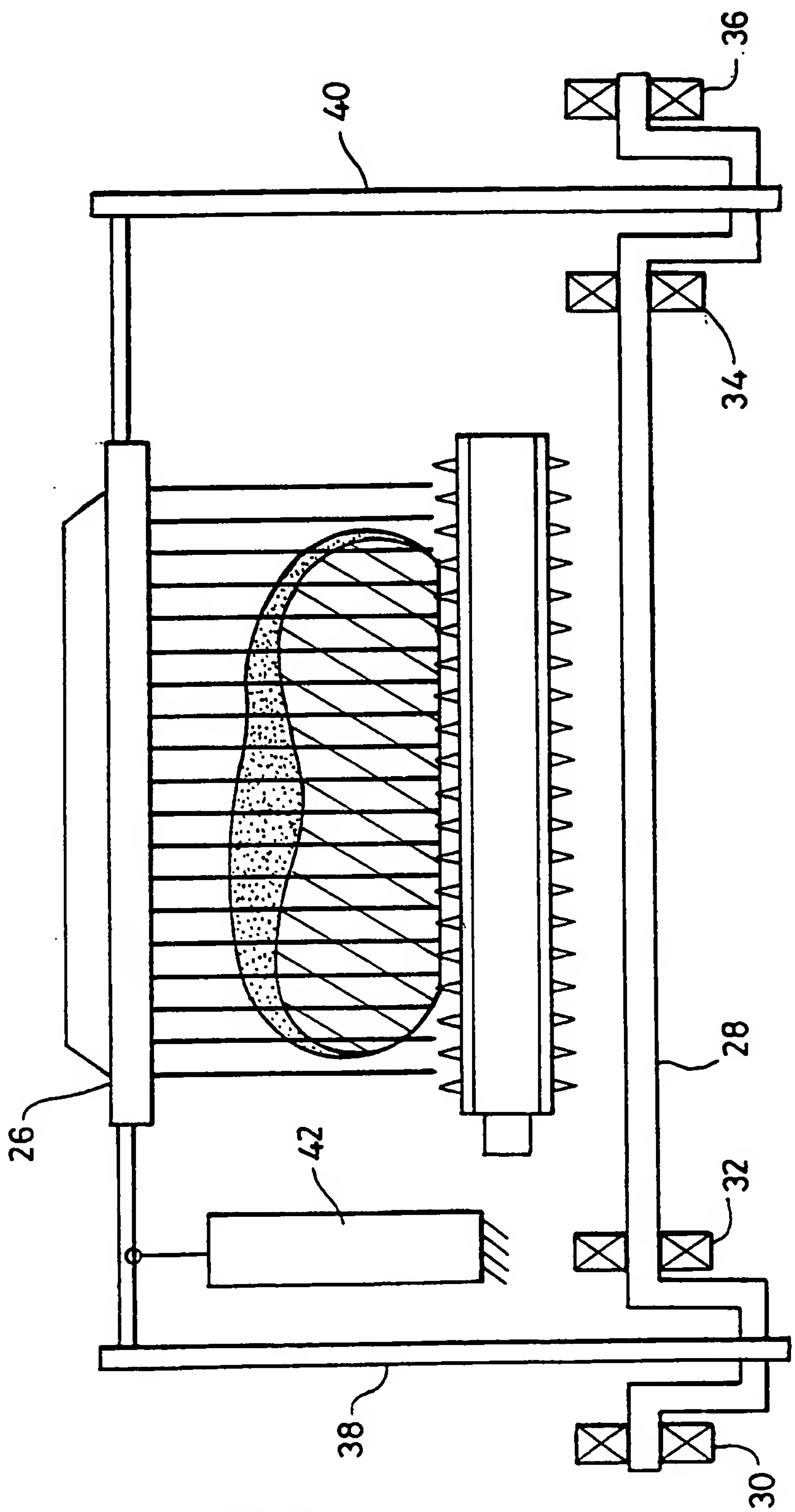


Fig. 4

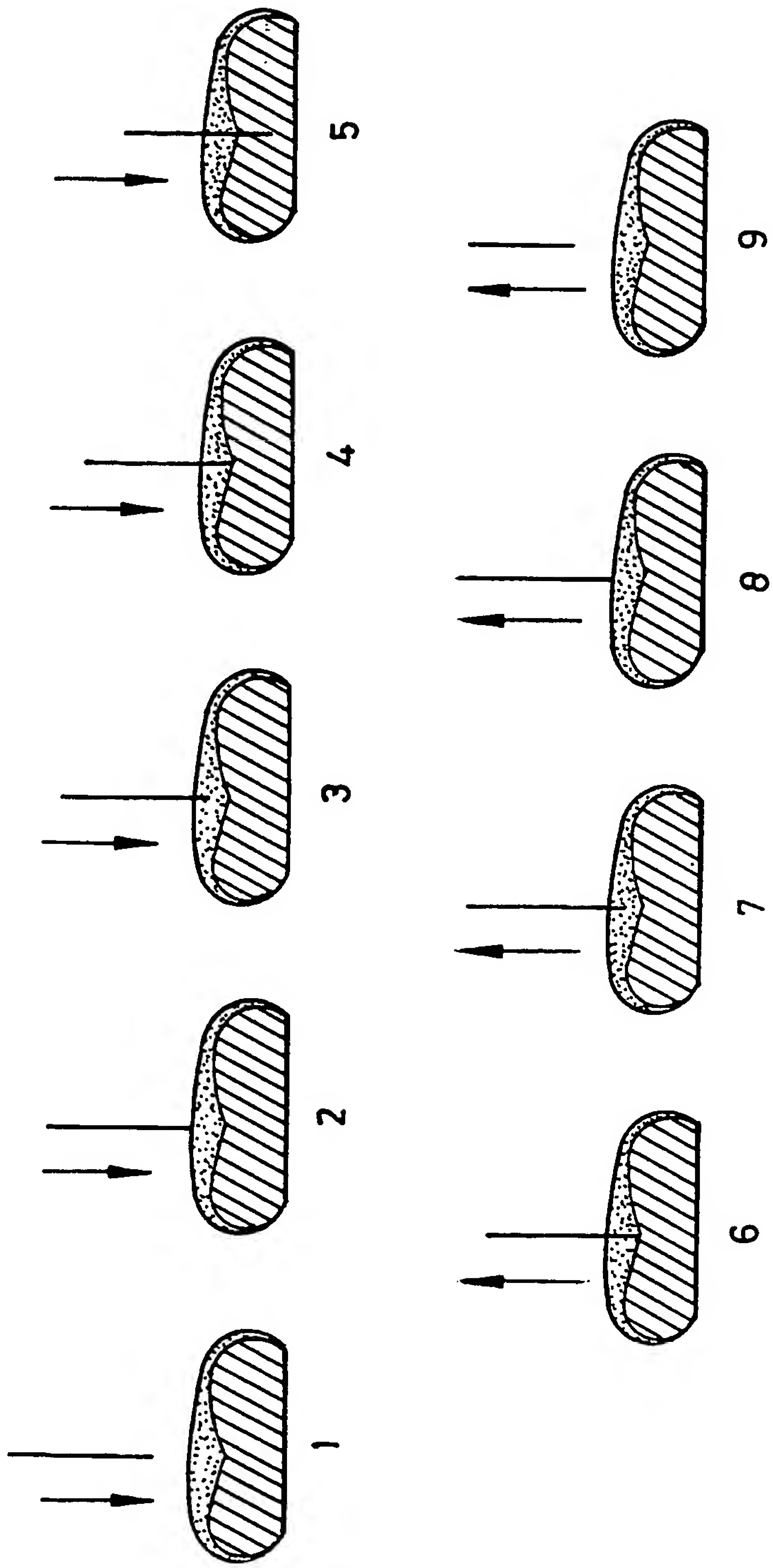


Fig. 5

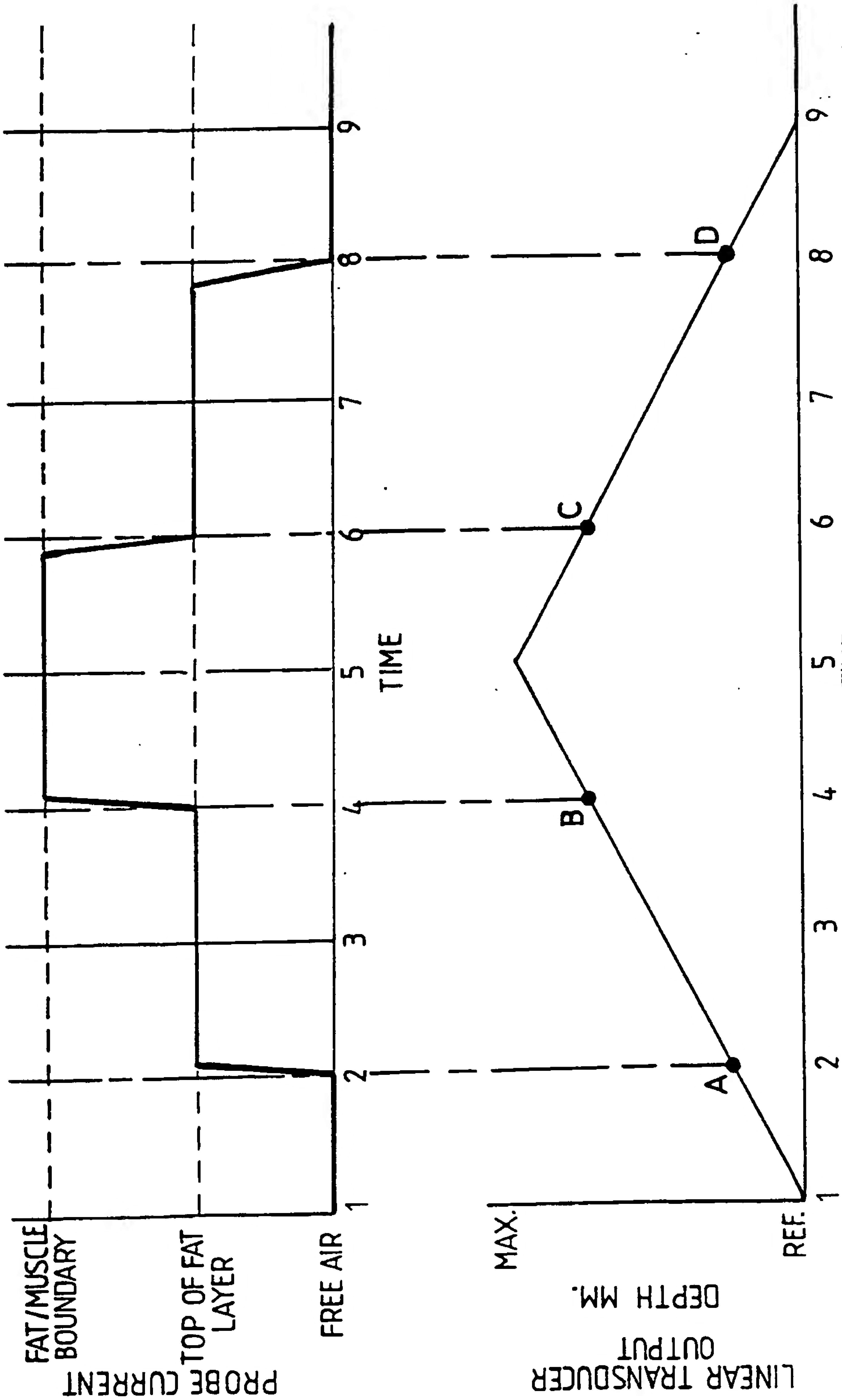

PROBE CURRENT
FAT/MUSCLE BOUNDARY
TOP OF FAT LAYER
FREE AIR
1
2
3
4
5
6
7
8
9
TIME
LINEAR TRANSDUCER OUTPUT
DEPTH MM.
MAX.
REF.
A
B
C
D

Fig. 6

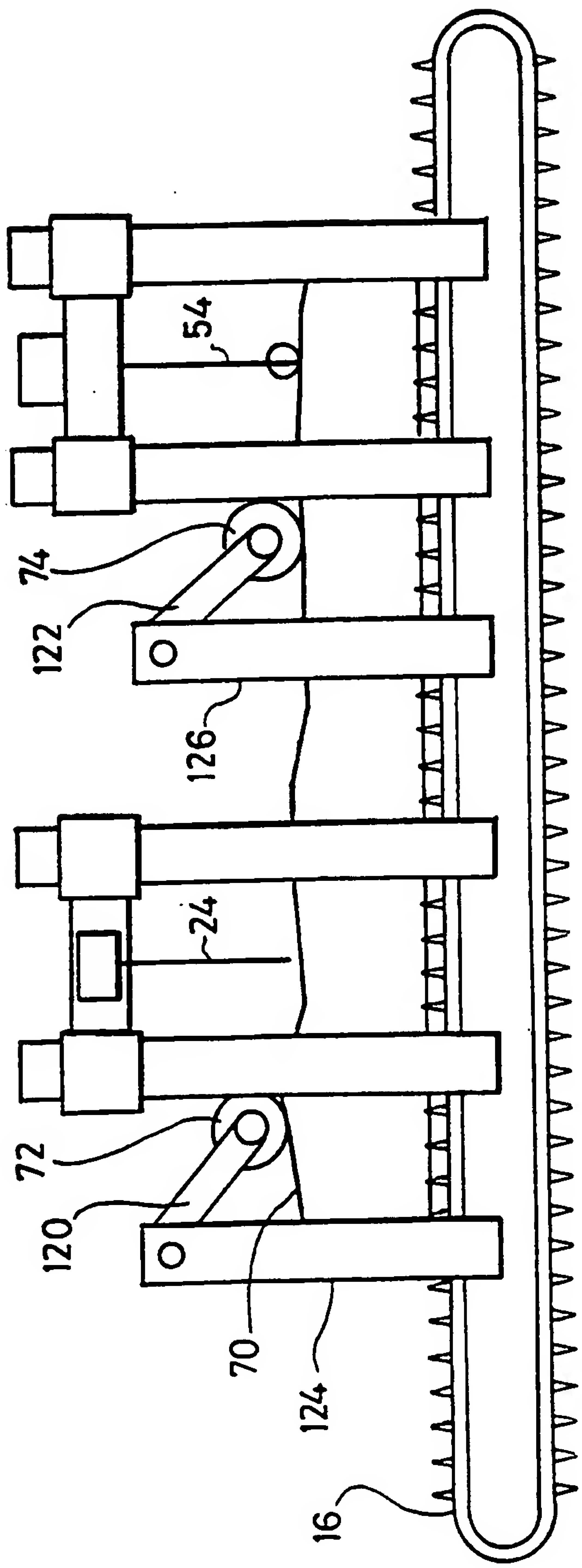


Fig. 7

7/7

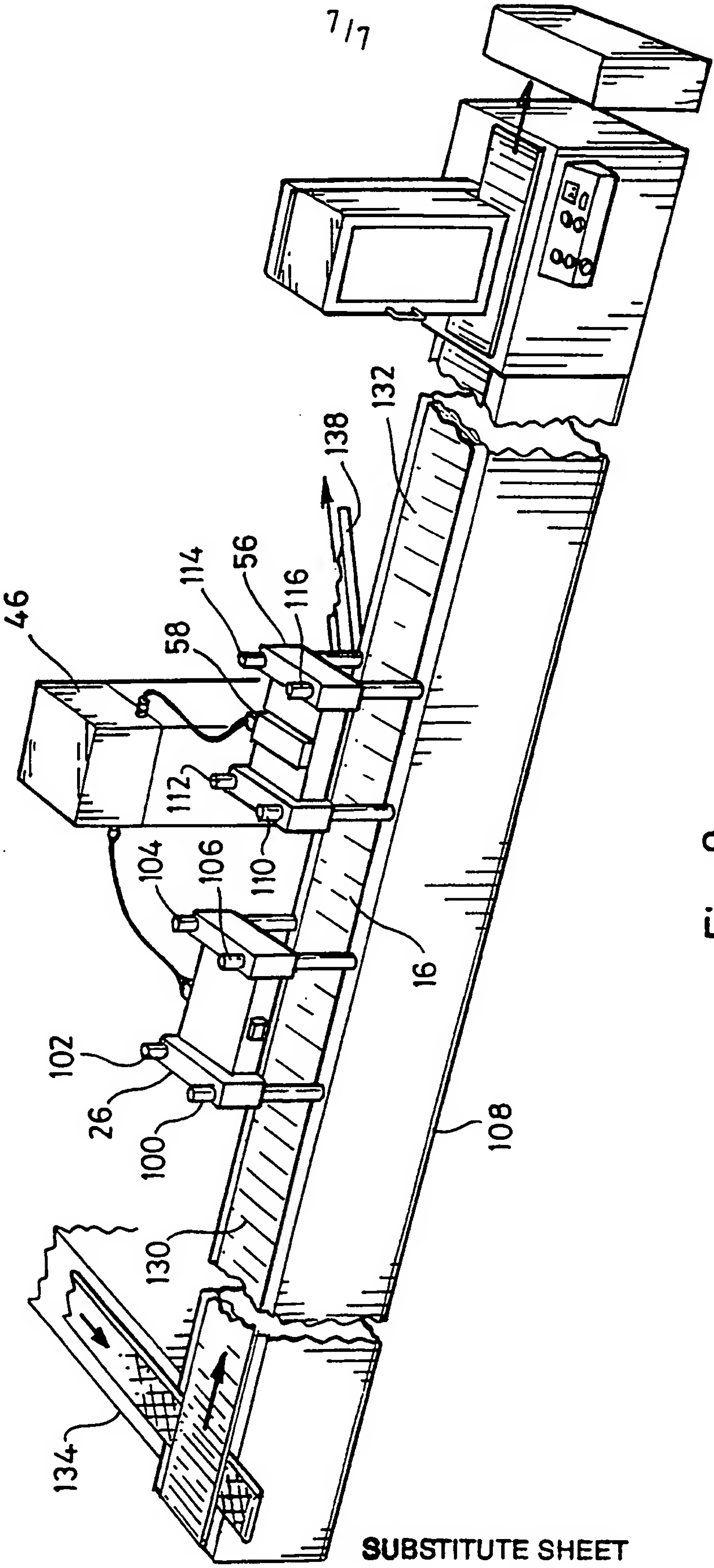


Fig. 8

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/GB 93/01564

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 G01B7/06 G01N33/12 A22C17/00 A22B5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 A22C A22B G01N G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US,A,4 246 837 (HAVERHILL MEAT PRODUCTS LIMITED) 27 January 1981 see the whole document ---	1-12, 15-21, 23,24,26
Y	US,A,4 209 878 (H.C.ALBERT) 1 July 1980 see the whole document ---	1-12, 15-21, 23,24,26
A	US,A,3 237 664 (C.D.MACY ; O.H.LINDSTROM) 1 March 1966 see the whole document ---	1-10,15, 16,24
A	FR,A,2 605 096 (F.CHAGNEAU ; M.LEVASSEUR) 15 April 1988 see the whole document --- -/--	1-9,16

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
23 November 1993	07.12.93

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	BROCK, T

Intern ıl Application No
PCT/GB 93/01564

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB,A,2 000 280 (H.BREITSAMETER) 4 January 1979 see the whole document ---	1-8,16
A	US,A,2 763 935 (R.M.WHALEY ; F.N.ANDREWS) 25 September 1956 ---	1,2,8,16
A	DE,A,21 07 114 (SLAGTERIERNES FORSKNINGSINSTITUT) 15 February 1971 see the whole document -----	1,2,8,16

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern   al Application No
PCT/GB 93/01564

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4246837	27-01-81	GB-A-	1594101	30-07-81
		AU-B-	523552	05-08-82
		AU-A-	3727078	03-01-80
		BE-A-	868290	20-12-78
		CA-A-	1100020	28-04-81
		DE-A,C	2826980	25-01-79
		FR-A,B	2394981	19-01-79
		LU-A-	79849	12-12-78
		NL-A-	7806657	22-12-78
US-A-4209878	01-07-80	NONE		
US-A-3237664		NONE		
FR-A-2605096	15-04-88	NONE		
GB-A-2000280	04-01-79	DE-A-	2728913	18-01-79
		BE-A-	868469	16-10-78
		CH-A-	641642	15-03-84
		NL-A-	7806910	29-12-78
US-A-2763935		NONE		
DE-A-2107114	23-12-71	GB-A-	1297474	22-11-72
		NL-A-	7102217	24-08-71
		SE-B-	373940	17-02-75
		US-A-	3671858	20-06-72